

tageous to keep the excited region completely filled with the stimulating radiation from the master oscillator for the duration of the excitation. This is illustrated in the above described embodiments wherein the short pulse elements which form the pulse train are stacked end-to-end with very small gaps or no gaps left between the individual pulses as they pass through the amplifier. For example, for a pulse train where the individual pulses are separated by approximately three nanoseconds, the duration of each pulse might also be approximately three nanoseconds, thus leaving little or no space between adjacent pulses comprising the pulse train.

Alternatively, since the lifetime of the excited species in an excimer laser, as well as other types of discharge-pump lasers, can be as long as several nanoseconds, it is possible to substantially improve the amount of pulse compression in accordance with the present invention by trimming the master-oscillator pulse to a length which is less than the length of time between adjacent pulses. For example, for a pulse train where the individual pulses are separated by three nanoseconds, the duration of each pulse might be two nanoseconds, thus leaving a one nanosecond space between adjacent pulses. The amount of energy lost from quenching of the excited states of the gain molecules during the one nanosecond gaps may be acceptable for many applications in light of the significant improvement in pulse compression.

A general guideline which may be used to determine the spacing between adjacent pulses is as follows: the space between adjacent pulses should be less than or equal to a distance in space determined by multiplying the speed of light times the energy-storage time of the gain medium.

Although the invention has been described in terms of a preferred embodiment, it will be apparent to those skilled in the art that numerous modifications can be made without departing from the spirit and scope of the claims appended hereto. Such modifications are intended to be included within the scope of the claims.

What is claimed is:

1. An X-ray lithography process comprising the steps of:
 - producing a laser pulse having a first time width; transferring energy from a lasing medium which is excited in pulses having a duration equal to an excitation time period to said laser pulse wherein said laser pulse first time width is less than said excitation time period thereby amplifying said laser pulse;
 - bombarding a target material with said amplified laser pulse to produce a plasma from which X-rays are emitted; and
 - exposing a mask/X-ray-resist substrate combination to said X-rays to replicate a desired pattern on said substrate.
2. The method defined in claim 1 wherein, said step of producing a laser pulse comprises:
 - outputting a laser pulse from a master oscillator having a first time duration; and
 - trimming said duration of said pulse from said master oscillator to said first time period.
3. The method defined in claim 1, wherein said step of transferring energy from a laser medium comprises passing said pulse through a gain region of a laser amplifier.
4. An X-ray lithography system comprising:

- a laser pulse generator for making a template laser pulse, said template laser pulse having a time duration equal to a first time period;
 - a laser amplifier medium having an excited region which is excited for a time duration equal to a second time period wherein said second time period is longer than said first time period, such that when said template pulse propagates in said excited region of said medium, energy is transferred from said laser medium to said template pulse thereby increasing the energy of said template pulse producing an amplified template pulse having a time duration substantially equal to said first time period;
 - an optical transport system for delivering said amplifying template pulse to a target material causing said target material to form a plasma from which X-rays are emitted;
 - a substrate;
 - an X-ray resist positioned on said substrate; and
 - a mask positioned over said resist, wherein said mask has a pattern which, when said X-rays are incident upon said mask, exposes portions of said resist to said X-rays thereby sensitizing said exposed portions of said resist.
5. An X-ray lithography system as defined in claim 4 further comprising a pulse train generator for generating a series of sequential pulses from said template pulse, wherein said series of sequential pulses has a total time duration equal to a third time period which is greater than said first time period.
 6. An X-ray lithography system as defined in claim 5 wherein said pulse train generator comprises:
 - a beam splitter for dividing said template pulse into a plurality of secondary template pulses which propagate along a plurality of optical paths; and
 - an optical delay for introducing time delays between at least two of said secondary template pulses.
 7. An X-ray lithography system as defined in claim 6 wherein said optical delay comprises a plurality of optical delays wherein each of said plurality of delays has a time duration equal to an integral multiple of said first time period.
 8. An X-ray lithography system as defined in claim 4 wherein said laser amplifier medium is an excimer laser.
 9. An X-ray lithography system comprising:
 - a pulse train generator which creates a pulse train comprising a series of individual pulses which are sequential in time;
 - a laser amplifier medium having an excited region wherein energy is transferred from said laser medium to said pulse train when said pulse train propagates through said excited region;
 - a pulse encoder which encodes each of said individual pulses comprising said pulse train;
 - a pulse train compressor for transforming said pulse train from a series of pulses sequential in time to a group of pulses coincident in time;
 - a target;
 - an optical transport system for delivering said coincident in time pulses to a common location on said target thereby forming a plasma from which X-rays are emitted;
- means for replicating an image wherein said means includes a substrate having an X-ray resist positioned thereon and a mask containing an image to be replicated, said mask positioned over said resist